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Muscle mass gain observed in patients with short bowel syndrome subjected to resistance training

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Abstract

Few studies are available about the evaluation of resistance training in patients with protein-energy malnutrition. To assess the effects of resistance training on the recovery of nutritional status of patients with short bowel syndrome, with a small bowel remnant of less than 100 cm, 9 patients of both sexes with protein-energy malnutrition after extensive resection of the small bowel were submitted to resistance training of progressive intensity consisting of concentric and eccentric work exercises for the upper limbs, trunk, and lower limbs, with the individuality and limitations of each patients being respected. Food consumption was monitored by 24-hour food recall performed during the initial phase of the study, before and 7 and 14 weeks after physical training, and by a dietary record for a period of 3 days of oral feeding. The nutrients administered by the enteral and parenteral route were recorded. A significant increase in total arm area ($P \leq .01$) and fat-free mass ($P \leq .01$) was observed as determined by computed tomography. An increase in total energy ingestion and carbohydrate consumption ($P \leq .01$) was also observed. In addition, the activity of the enzyme carnosinase was increased after resistance training ($P \leq .01$). The present results show that resistance training in patients with short bowel syndrome and protein-energy malnutrition can be considered to be a part of the nonmedicamentous treatment of these patients, leading to better nutrient use and to a gain of lean mass.

Keywords: Human; Protein-energy malnutrition; Short bowel syndrome; Physical activity; Resistance training

Abbreviations: E.C., *Escherichia Coli*; KV, kilovolt; Mg/creat/24 h, milligram of creatinine in 24 hours; μmol/ml/h, micromole per milliliter per hour; USP, University of São Paulo.

1. Introduction

Short bowel syndrome occurs after extensive resection of the small bowel. Among the causes of mesenteric ischemia are emboli and infarction of the superior mesenteric artery [1]. Because of the loss of an extensive portion of the small bowel, the patients develop severe protein-energy malnutrition, requiring parenteral nutrition during the immediate and late postoperative period, a fundamental procedure for increased survival [2].

The nutritional status expresses the extent to which the physiologic nutrient requirements are being met to maintain adequate composition and function [3]. Malnutrition predisposes to a series of severe complications including a

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tendency to infection, deficient wound healing, respiratory failure, cardiac insufficiency, reduced protein synthesis at the hepatic level with production of abnormal metabolites, and reduced glomerular filtration and production of gastric juice [4]. Physical inactivity causes muscle weakening, drastically reducing the capacity to generate muscle work, affecting the ability to "live independently" [5,6]. Resistance or strength physical training has been pointed out as the cause of positive hypertrophic adaptation of skeletal muscle [7].

Training with resistance or strength exercises can help reverse the malnutrition commonly occurring among patients with renal failure. This type of training is characterized by weight lifting, which results in increased muscle mass, improving physical function and attenuating progressive muscle loss [8].

In a study in which a low-protein diet potentially inducing malnutrition was administered to male Wistar rats to determine the physiologic and metabolic changes because of malnutrition in a control and in an exercised group, Neiva et al [9] concluded that malnutrition associated with sedentarism causes important alterations in patterns considered to be normal, with physical exercise potentiating the results obtained and aiding nutritional recovery.

To our knowledge, few data are available about resisted physical exercise applied to patients who underwent enterectomy. Thus, there is an urgent need to transmit information about the importance of resistance training as part of treatment to the professionals involved in the recovery of patients with protein-energy malnutrition. On the basis of the information, we believe that resisted physical exercise is associated with improved nutritional status in patients who underwent enterectomy, aiding their nutritional recovery.

2. Methods and materials

2.1. Patients

A total of 9 patients with short bowel syndrome, 4 women and 5 men older than 30 years followed at the Metabolic Unit of the University Hospital, Faculty of Medicine of Ribeirão Preto, University of São Paulo (São Paulo, Brazil), participated in the study. The study was approved by the research ethics committee of the University Hospital, Faculty of Medicine of Ribeirão Preto, University of São Paulo, and all patients gave written informed consent to participate.

2.2. Experimental design

The patients were submitted to evaluation of nutritional status before and after 14 weeks of resistance physical training, with each individual acting as his own control. The evaluation consisted of anthropometry, evaluation of food intake by 2 types of dietary survey, 24-hour diet recall and 3-day food record, and measurement of energy expenditure by indirect calorimetry. Computed tomography was used as the imaging method. The patients were submitted to resistance training twice a week for a period of 14 weeks. The inclusion criterion was not to have participated in any type of regular physical exercise in the last 12 months. The evaluation of nutritional status was repeated after the period of physical training. All evaluations were performed before and after the resistance training. Each individual served as his own control. Each evaluation method and the respective references are described below.

2.3. Anthropometry

The anthropometric measurements performed were weight, height, skin folds, arm circumference, and calculation of arm muscle circumference [10], and the results were defined as mild, moderate, and severe malnutrition [11].

2.4. Laboratory data

Venous blood samples were collected and used to determine total proteins, albumin, and carnosinase (*Escherichia coli*: 3.4.13.20) [12]; 24-hour urine samples were also obtained. Urinary creatinine level was determined by reaction with a picrate solution in alkaline medium, forming a red complex that was measured photometrically. The determination was performed using a Labtest kit (Lagoa Santa, Minas Gerais, Brazil) and a Beckman DU640 spectrophotomer (Corona, CA) at 510 nm.

2.5. Evaluation of food intake

Food intake was determined by the sum and the mean of the results obtained with the 24-hour diet recall, with the 3-day diet record [13] and with enteral and parenteral nutrition. The data were analyzed before and after physical training. Food intake was calculated with the aid of a computer program (Programa de Apoio à Nutrição [Nutrition Support Program] version 2.5, licensed by Escola Paulista de Medicina—Nutritional therapy, São Paulo, Brazil).

2.6. Measurement of resting energy expenditure

Resting energy expenditure was determined before and after the end of physical training using a Sensor Medics calorimeter (Sensor Medics Corporation, Yorba Linda, Calif) [14].

2.7. Computed tomography

Images of the midpoint of the nondominant arm were obtained (Tomoscan LX-C, Matrix 512 and 320; Eastlake, OH) at a speed of 9.5 seconds at 30 kV. The axis was oriented at 90° using a 256 × 256 matrix. Readings of total area and of muscle and bone areas were obtained with a Mini-Moop digitizing board (Eching, Bavaria, Germany) plus an associated computation program using a digital pen to circle the figure exposed on photographic paper to measure the different areas (total area, muscle area, and bone area). To determine the muscle area, bone area was measured and subtracted from muscle area, and to determine the adipose area, the muscle and bone areas were summed and the value was subtracted from the total area [15,16].